The landmark Americans with Disabilities Act (ADA), enacted on July 26, 1990, provides comprehensive civil rights protections to individuals with disabilities in the areas of employment (title I), State and local government services (title II), public accommodations and commercial facilities (title III), and telecommunications (title IV). Both the Department of Justice and the Department of Transportation, in adopting standards for new construction and alterations of places of public accommodation and commercial facilities covered by title III and public transportation facilities covered by title II of the ADA, have issued implementing rules that incorporate the Americans with Disabilities Act Accessibility Guidelines (ADAAG), developed by the Access Board.

U N I T E D S T A T E S A C C E S S B O A R D
A FEDERAL AGENCY COMMITTED TO ACCESSIBLE DESIGN

ADA Accessibility Guidelines for Buildings and Facilities (ADAAG)
3.5 Definitions.
Assembly Area. A room or space accommodating a group of individuals for recreational, political, social, civic, or amusement purposes, or the consumption of food and drink.

4.1.3. Accessible Buildings:
New Construction. Accessible buildings and facilities shall meet the following minimum requirements [...]

(19)* Assembly areas
(b) This paragraph applies to assembly areas where audible communications are integral to the use of the space (e.g., concert and lecture halls, playhouses and movie theaters, meetings rooms, etc.). Such assembly areas, if (1) they accommodate at least 50 persons, or if they have audio-amplification systems, and (2) they have fixed seating, shall have a permanently installed assistive listening system complying with 4.33.

For other assembly areas, a permanently installed assistive listening system, or an adequate number of electrical outlets or other supplementary wiring necessary to support a portable assistive listening system shall be provided. The minimum number of receivers to be provided shall be equal to 4 percent of the total number of

ASSISTIVE LISTENING SYSTEMS

BULLETIN 9C: FOR PROVIDERS

What are assistive listening systems (ALSs)?

Assistive listening systems (ALSs) are devices designed to help people with hearing loss improve their auditory access in difficult and large-area listening situations. Typically, these devices are used in such venues as movie houses, theaters, auditoriums, convention centers, and stadiums, where they are piggybacked on a public address system. They may also be used in smaller listening locations like courtrooms, museums, classrooms, and community centers.

Even though a public address (PA) system is in use, sound signals have to travel from the loudspeaker(s) to the listener's seating position. Depending upon the particular site, this distance may be anywhere from a few feet to well over a hundred feet. Whenever sound signals travel acoustically, they lose volume over distance and are subject to distortion and masking from background noise and reverberation.

The sound signals delivered by the ALS do not travel through acoustical space before arriving at listeners' ears. Thus, they are not weakened by distance or degraded by noise and reverberation during the transmission process. Instead, signals are transmitted via electromagnetic, radio, or light waves to specialized receivers used by listeners. An ALS eliminates the last acoustical leg of the signal transmission path, providing listeners with hearing impairments with a parallel transmission path that short-cuts the usual delivery process.

It is important to note that ALSs are not intended as substitutes for hearing aids but as supplements to hearing aids. ALS can also be used to improve functional hearing abilities for people who don't use hearing aids. Assembly facility operators may need to provide more than one type of device in order to serve all audiences.

How do ALS function for people with hearing loss?

Audibility and comprehension are not the same. One of the most frequent complaints voiced by people with hearing impairments is that they hear someone talking without understanding what is being said. Even in what appear to be adequate listening conditions, people with hearing loss may struggle to understand. In rooms with excessive noise and reverberation, comprehension can become impossible. While hearing aids can restore some of the reduced loudness caused by a hearing loss, they cannot separate the primary signa – the

seats, but in no case less than two. Signage complying with applicable provisions of 4.30 shall be installed to notify patrons of the availability of a listening system.

4.30 Signage.
4.30.7* Symbols of Accessibility.
(4) Assistive Listening Systems.
In assembly areas where permanently installed assistive listening systems are required by 4.1.3(19)(b), the availability of such systems shall be identified with signage that includes the international symbol of access for hearing loss (see Figure 1).

Figure 1: International Symbol of Access for Hearing Loss

4.33 Assembly Areas
4.33.6* Placement of Listening Systems.
If the listening system provided serves individual fixed seats, then such seats shall be located within a 50 ft (15 m) viewing distance of the stage or playing area and shall have a complete view of the stage or playing area.

4.33.7* Types of Listening Systems.
Assistive listening systems (ALS) are intended to augment standard public address and audio systems by providing signals which can be received directly by persons with special receivers or their own hearing aids and which eliminate or filter background noise. The type of assistive listening system appropriate for a

desired sound – from the undesired background noise. In fact, they amplify both. Thus, hearing aids cannot improve the speech-to-noise ratio (S/N), which is the intensity level of the speech signal relative to background noise. People who have hearing loss need high S/N ratios to comprehend sound signals.

ALSs work to overcome the deleterious effect of the intervening acoustical conditions by bypassing them. They deliver the desired sound signal directly to the listener's ear, which increases the speech-to-noise ratio. This permits people with hearing loss to function to the limits of their residual hearing capacities.

ALSs do more than improve basic speech perception capabilities in large-area listening situations. Often people with hearing impairments are able, by expending a great deal of energy and effort, to understand speech signals in such places. They can get the message, but they have to focus so intently on receiving the spoken message that they have difficulty attending to what is being said. Unlike people with normal hearing, they may not be able to relax and enjoy an entertainment experience or focus effectively for long periods of time in an education setting. The use of ALSs can minimize this listening fatigue.

Are ALSs required in assembly facilities?

The Americans with Disabilities Act of 1990 (ADA) requires that buildings and facilities be accessible to and usable by people with disabilities. This includes communications access for people with hearing loss.

The ADA Accessibility Guidelines (ADAAG), adopted as the ADA standards for accessible design by the Department of Justice (DOJ) in 1991, require that certain newly constructed and altered assembly facilities be designed and constructed to include assistive listening systems (see the sidebar for ADAAG scoping and technical provisions). In addition, DOJ regulations implementing title II (covering the public sector) and title III (covering the private sector) of the ADA include requirements for effective communication with people with disabilities that may require the installation of fixed or portable ALSs in existing assembly facilities (see sidebar).

The ADA does not cover private clubs and entities that are operated and controlled by religious organizations. However, many houses of worship make ALSs available to their congregants, not as a matter of law but as a service to their people, and club facilities used by other organizations must support ALSs required for meetings and performances.

Consumers who use assistive listening devices report dissatisfaction with the quality of many systems provided in assembly areas. Device use rates and patterns may have been artificially depressed due to the lack of effectiveness and/or compatibility of many systems now installed. Demographics suggest that use of ALSs will increase as our population ages. It is likely also that current technologies will advance as new requirements are implemented.

What types of systems are currently available?

There are three basic types of large area assistive listening systems:

Induction Loop (Figure 2)

In the first type, the induction loop (IL) system, a loop of wire encircles the listening area (or is embedded in a mat or placed under a rug). This loop of wire is connected to the amplifier output of a public address (PA) system instead of, or in addition to, the usual loudspeaker. The IL system produces an electromagnetic field around the wire. These electromagnetic signals are accessed by listeners with hearing impairments through telephone coils found in many hearing aids (about 30% of hearing aids include "T" coils). While these "T" coils were originally included in hearing aids to improve telephone communication, they will respond to any electromagnetic field. When the

particular application depends on the characteristics of the setting, the nature of the program, and the intended audience. Magnetic induction loops, infra-red and radio frequency systems are types of listening systems which are appropriate for various applications.

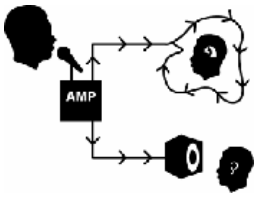

Figure 2: An Induction Loop (IL) System

electromagnetic field emanating from the wire loop intersects these coils, it induces an alternating electrical current in the coil. This electrical current is then processed by the hearing aid in the same way that it processes acoustical (sound) signals reaching its microphone. The major advantage of IL systems is that listeners whose hearing aids include "T" coils always have an ALS receiver with them. All they have to do to get tuned in is switch their hearing aids to the telecoil ("T") position when entering a looped area.

Facilities with IL systems must provide separate telecoil receivers for people who do not use hearing aids. These receivers come in various shapes and sizes, but all contain a wire coil to detect the electromagnetic field and an amplifier to increase the signal level.

Problems reported with IL systems include spill-over of the magnetic field into adjacent areas (both horizontally and vertically); susceptibility to stray electromagnetic fields; variations in the electromagnetic field within the loop; and issues related to the quality and physical orientation of the telecoils. With a proper installation and appropriate hearing aids, all of these problems can be eliminated or minimized for satisfactory operation.

FM (Figure 3)

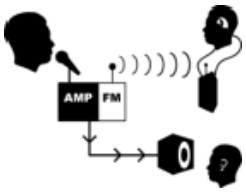

Figure 3: An FM System

The second type is the FM system. An FM assistive listening system is simply a variation on the commercial FM radio. The signals are broadcast by FM transmitters and picked up by listeners using an FM receiver tuned to the transmitting frequency. These receivers must be made available by the facilities that use FM ALSs. The FCC has reserved two non-commercial bands for auditory assistance devices. The lower band is a non-exclusive band, which means that interference from other users in the same frequencies may occur (such as from emergency vehicles of various kinds). The effective range of the lower FM band is a radius of about 300 to 500 feet; that of the upper band approximately twice that.

There are several potential problems with FM systems. The first is that privacy is not possible. The FM signals do not stay contained within the four walls of an enclosure. If privacy is a consideration, then an FM system is not appropriate for that facility. The second potential problem is the obverse of the first: radio signals originating outside of the facility can enter the facility and interfere with reception. One cannot prevent occasional interference, as when an emergency vehicle in the area transmits on the same frequency used in the venue. However, persistent interference can usually be overcome by selecting alternate frequencies within the permitted bands. On the up-side, it is relatively easy with an FM system to ensure adequate signal strength at all seat locations, even in the largest venues.

Infrared (Figure 4)

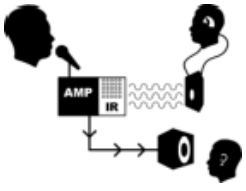

Figure 4: An Infrared (IR) System

The third type of ALS is the Infrared (IR) light system. In an IR system, audio signals from any source are conveyed to listeners via infrared light waves (using light emitting diodes) invisible to the human eye. The light waves are picked up by a photo detector diode contained within an optical bubble on the IR receiver. The receiver extracts the audio information from the IR signal and delivers an amplified version to the ears of a listener. Ordinarily, strict line-of-sight is necessary between an IR emitter and the transparent lens on the receiver, but this can be modified in rooms with light-colored surfaces (the IR waves are reflected off them) or by adding additional emitters. Since IR systems are light waves, they exhibit the advantages and disadvantages of light waves. The IR signals will be contained within a room, thus ensuring privacy, and adjacent rooms in a facility can use IR systems without fear of inter-room interference. They are also not as subject to radio or electromagnetic interference as are FM systems. However, outdoor use is problematic because of the effect of sunlight (which contains a great deal of infrared energy) and it is more difficult to cover the largest venues with IR systems.

DOJ Title II rule
DEPARTMENT OF JUSTICE
28 CFR PART 35
Nondiscrimination on the Basis of Disability in State and Local Government Services
Subpart A -- General
35.104 Definitions
Auxiliary aids and services includes—
(1) Qualified interpreters, notetakers, transcription services, written materials, telephone handset amplifiers, assistive listening devices, assistive listening systems, telephones compatible with hearing aids, closed caption decoders, open and closed captioning, telecommunications devices for deaf persons (TDD's), videotext displays, or other effective methods of making aurally delivered materials available to individuals with hearing impairments.

Subpart E – Communications
35.160 General.
(a) A public entity shall take appropriate steps to ensure that communications with applicants, participants, and members of the public with disabilities are as effective as communications with others.
(b)(1) A public entity shall furnish appropriate auxiliary aids and services where necessary to afford an individual with a disability an equal opportunity to participate in, and enjoy the benefits, of a service, program, or activity conducted by a public entity.
(2) In determining what type of auxiliary aids and service is necessary, a public entity shall give primary consideration to the requests of the individual with disabilities.

All IR systems require a radio-frequency (RF) sub-carrier as an intervening step between the audio and the light waves. Compatibility between venues has always been a major advantage of IR systems, although electromagnetic interference produced by the newer, more energy efficient, fluorescent lights has led some facilities to change frequencies. This will not be a problem for consumers as long as the facility provides them with compatible IR receivers. Commercial IR receivers haven't yet been manufactured to detect all the possible sub-carrier frequencies.

How do I know which type is appropriate for my facility?

Facilities, particularly larger ones, are well-advised to consult with a professional sound contractor, preferably one with experience in installing ALSs, before purchasing any system. An experienced installer will lead you through the steps that are necessary to ensure that both you and your patrons will be happy with the results. Below are just some of the considerations that you and the installer will jointly consider:

- Is privacy a major consideration? Is it necessary that the events taking place within a facility be inaccessible to people outside the enclosure? If so, then an IR system must be employed.

- Are a large number of simultaneous events going to be taking place in adjoining facilities? While there are a sufficient number of potential FM carrier frequencies available to ensure non-interference between rooms, and thus an FM system is a possibility, it will then be necessary to provide FM receivers that can be tuned to all the possible frequencies. How will your audience respond to the necessity to change frequencies? Do you care if someone in one room can tune in to events in a different room? If these possibilities can cause problems, then an IR system will be best.

- Is it going to be necessary to use the system alternately in a number of different rooms (such as in a community center, from one activity room to another)? Ordinarily, FM system are somewhat more flexible and can be used both indoors and out (as in a tour group). However, some IR systems are also relatively easy to deploy, and portable units will work well in the smaller activity rooms, though they will not operate as effectively outdoors.

- Is your facility very large? Is it a massive auditorium with balconies, overhangs, and other nooks and crannies? While a skilled person can install an IR system in such locations, it is easier to ensure an appropriate signal at all seat locations with an FM system. Is much of the action going to take place outdoors (as at a race track)? In this case too, your best bet would be an FM system.

- Is your facility being bombarded by stray FM transmissions? Your installer will use a frequency scanner to determine the possibility of interference. If the interference is likely to persist, then an IR system would be the best bet.

- In facilities where a large percentage of users are likely to have "T" coils in their hearing aids, IL systems are probably the simplest system to manage, since the IL receiver is simply the telecoil in the person's own hearing aid. However, an IL system must also make specialized IL receivers available to others, including hearing aid users whose devices don't include telecoils and to listeners who don't use hearing aids at all.

What types of receivers and coupling arrangements are available?

Receivers induce the greatest variability in system effectiveness for listeners and offer the greatest opportunity for gain. Interference is a major concern, but coupling arrangements are also a concern. Because ALS users may be listening with or without aids, a variety of connections must be provided. Standardized

AND TITLE III: PART 36 NONDISCRIMINATION ON THE BASIS OF DISABILITY BY PUBLIC ACCOMMODATIONS AND IN COMMERCIAL FACILITIES

36.303 Auxiliary aids and services.

(a)General. A public accommodation shall take those steps that may be necessary to ensure that no individual with a disability is excluded, denied services, segregated or otherwise treated differently than other individuals because of the absence of auxiliary aids and services, unless the public accommodations can demonstrate taking those steps would fundamentally alter the nature of the goods, services, facilities, privileges, advantages or accommodations being offered or would result in an undue burden, i.e., significant difficulty or expense.

(b) Examples. The term "auxiliary aids and services" includes – (1) Qualified interpreters, notetakers, computer-aided transcription services, written materials, telephone handset amplifiers, assistive listening devices, assistive listening systems, telephones compatible with hearing aids, closed caption decoders, open and closed captioning, telecommunications devices for deaf persons (TDD's), videotext displays, or other effective methods of making aurally delivered materials available to individuals with hearing impairments; […]

(c) Effective communication. A public accommodation shall furnish appropriate auxiliary aids and services where necessary to ensure effective communication with individuals with disabilities.

connectors are needed to serve listeners with in-the-ear, behind-the-ear, and other hearing aids; people who have cochlear implants; and users whose hearing is not aided. ALSs can also be used to provide audible description.

All receivers should be binaural/stereo. Neckloops and silhouettes are the recommended connection between receiver and ear (aided or unaided). Neckloops are compatible with telecoil-equipped hearing aids and can also provide for direct input (DAI). They are easy to use, comfortable to wear, hygienic, and allow binaural hearing use. They can be turned off for conversation. With the addition of a standard 1/8-inch jack at the receiver, direct coupling to a personal aid or cochlear implant is possible. Silhouette (transducer) couplings are also compatible with telecoil-equipped hearing aids, but may not be as comfortable to wear.

Ear buds are useful only to those with normal hearing or mild hearing loss. They are not binaural, and are a better vehicle for audio description than for assisted listening.

Overall ALS sound quality is a function of multiple factors, including:

- microphone quality, placement, and use in a public address system;
- equipment quality and maintenance;
- room acoustics;
- room proportion, surface, and use
- listener location and orientation with respect to transmitting devices;
- hearing aid type and condition; and
- compatibility between coupling devices and aids (if any).

FM receivers are about the size of a pack of cigarettes and include on/off switches and volume controls. The receivers may be worn hung around the neck, clipped to a belt or placed in a pocket. They connect to headsets, earbuds, or neckloops. People who use hearing aids may prefer to use a neckloop that does not require a fitting over the ear. It is plugged into the receiver earphone jack and transmits an electromagnetic field to a hearing aid telecoil. This inductive coupling is a convenient way to use an ALS receiver, since it enables people to continue to use their personal hearing aids. However, only about 30% of modern hearing aids include telecoils (mainly because of size restrictions – they won't fit into the smallest hearing aids). Other hearing aid (behind-the-ear type) or cochlear implant users may prefer to directly connect their aid to the earphone jack on the receiver using a patch cord of their own.

Infrared (IR) body pack receivers are similar to FM receivers and employ the same coupling arrangements (headphones, earbuds, neckloops, patchcords). The major difference is that every IR receiver has an optical bubble which collects the IR light wave for processing by a photo-optical circuit. IR receivers are also available in forms not available with FM receivers, such as under-the-chin stethoscope units and self-contained headphones. Stethoscope units place the electronics, volume control and optical bubble in a single unit that dangles from a user's ears. Some of these units also include an output jack for insertion of a neckloop.

Where inductive loop (IL) systems are installed, listeners who have telecoil-equipped heaing aids need only turn on the switch to activate the ALS. It will be necessary to provide specialized receivers that contain a telecoil to deliver the sound through a hearing aid or by means of a headset or earbud.

How many receivers should I make available?

The number of receivers should be equal to at least four percent of the total number of seats available, with a minimum of two in any facility with fixed seating of 50 or more.

What kinds of signs and public notification of ALS's should I provide?

While not required by the ADA, it is advisable for venues to note the availability of ALSs in all of their media publicity (including printed ads, TV and radio announcements, recorded telephone messages). People who require an ALS should know that one is available – and what type it is – before they make plans to attend an event.

What is required by the ADA is visible signage at the facility that notes the availability of an ALS and information on where receivers can be checked out. These signs should be placed at several prominent locations within the facility, certainly including one at or near the box office.

Who has the responsibility for managing the receivers?

Every facility that provides an ALS should designate someone to be responsible for checking the receivers in and out and for ensuring that they are working correctly. This is not a responsibility that venues should treat lightly. Neither the ticket seller at the box office or the clerk at the refreshment stand will be able to manage distribution, trouble-shooting, and collection of ALS receivers in large venues. Patrons should not have to search the facility for someone to return the receiver to at the close of the program to redeem their driver's license (or other ID). A fixed location is best, staffed by a trained employee assigned this responsibility.

The staff member should understand the basic principles of the ALS and the operation of the receivers and coupling devices and be able to show patrons how to turn the system on and off. Technical assistance should be available during a performance for malfunctioning devices.

What are the probable expenses in purchasing and maintaining an ALS?

For a movie theater, small auditorium, or large meeting room or lecture hall, the purchase of a wide-area FM transmitter will cost between $600 and $1200 and will include three or four receivers with the package. Additional single channel receivers will run about $100 each, while multi-channel receivers are more expensive. If rechargeable batteries are to be used (ordinarily recommended), then it is necessary to add the cost of a pocket recharger/storage case. A sixteen-pocket recharger costs about $500. Infrared systems tend to be a bit more expensive, ranging between $800 and $2500 for a similar venue, depending upon the number of emitters required to cover the seating area. Infrared receivers also tend to be just a bit more expensive than FM receivers and installation expenses are somewhat higher for an IR than an FM system. Considering the usual expenses in operating any kind of assembly facility, however, the cost of any type of ALS is a relatively small item.

Maintenance costs should also be minimal. Depending upon how often the system is used, rechargeable batteries in the receiver should last well over a year. The disposable tips on earbuds should be changed after each use, but this costs only pennies. Periodically, a receiver will have to be replaced. This does not happen too often. Rather than have some irate customer call your attention to a malfunctioning receiver, it is best that problems be detected before receivers are handed out to patrons. Using a staff member as the ALS receiver "caretaker" is probably the greatest ongoing expense associated with ALS's. It may take an hour or so to check the receivers in and out, which includes troubleshooting the receivers to ensure their proper operation.

What is involved in installing an ALS?

Let's first consider the goal, which is to ensure both an adequate and high-quality signal (electromagnetic, radio, or light wave) at all seat locations within a facility. By an adequate signal, we mean one that is strong enough to be properly

processed by the correct receiver (FM, IR, or "T" coil). By high quality, we mean a signal that meets defined electroacoustic standards. Given these goals, then the most significant decision a provider can make is to select a knowledgeable and experienced sound contractor. Many venues also have in-house personnel with basic expertise in amplification technologies. Staff should consult with manufacturers in determining what type of ALS should be selected and how it should be installed.

In smaller venues, such as community and senior centers and houses of worship, it is not likely that an in-house expert will be available. More likely than not, the maintenance person, the site's administrator, or a computer or communications "techie" will be the one on whom the installation responsibility will fall. Even here, however, it is desirable to seek expert advice. This can be obtained from local audiologists and from the representatives of the various companies that manufacturer ALSs. These "reps" are a particularly good source of information; while not professional installers, they are usually able to offer good advice and information. In any facility where there is an existing sound system, the most economical and efficient way to proceed is to piggy-back the ALS on this system.

What kinds of problems may occur after an ALS has been installed?

Some of the more common problems are enumerated below, along with solutions:

- Distorted or no sound coming from FM or IR receivers: Solutions: (1) Check all batteries (rechargeable and disposable) before using. (2) Check that VU indicator on transmitter shows correct reading.

- Sound is coming from the loudspeakers, but not the ALS. Solutions: (1) Check to see that the system is turned on (piggybacking the ALS to the PA system would preclude this problem). (2) Check receiver batteries.

- IR signals are weak or distorted. Solutions: (1) Check that IR emitters have not been moved or covered with some object. (2) Check that the optical bubble on the personal receiver is not being covered. (3) Check batteries. (4) Check VU reading on transmitter.

- Spurious radio signals being detected by FM receiver. Solutions: (1) Change transmitting frequency (remember to vary receiver frequency as well). (2) Use frequency scanner to determine a "clean" channel.

- FM systems picking up signals from adjoining locations. Solution: Check that FM receiver is tuned to the correct channel.

- With IR systems, dead spots in the listening area. Solution: Check with the manufacturer/installer. It is possible that the emitters will have to be re-oriented or additional ones installed.

- Receiver okay, but patron is using a hearing aid that doesn't pick up signal. Solutions: (1) When receiver is coupled to a neckloop, check that hearing aid is in the "T" position. (2) Problem may reflect an inoperable hearing aid; check that patron can hear with hearing aid when not using the ALS.

How many people in our society can benefit from an ALS?

The statistics regarding the number of people with hearing loss in our society vary depending upon the source and the criteria used to define hearing loss. Most sources give this number as between 24 and 28 million people, or about 10 percent of the population. Hearing-impairment increases with age. It is estimated that about 50% of persons over the age of 65 have some degree of hearing impairment. Additionally, the incidence of noise-induced hearing loss has

increased over the last two decades. Due to increased longevity and the aging of our population, the total number and proportion of people with hearing loss is likely to increase substantially in the future. Most of these people will enjoy greater perception with less listening effort when using an ALS in assembly areas where audible communication is integral to the use of the space. People receiving direct assistance from an ALS are not the only ones involved. People do not usually attend events by themselves. If one considers those family members who would be accompanying the person with a hearing loss, then it is apparent that the total number of people who would be potentially impacted by the availability of an ALS is even greater than 28 million.

Many people with hearing impairments have stopped attending all kinds of public events because they can't hear what's going on or they have to work too hard to comprehend the proceedings. By improving auditory access, facility operators can encourage increased attendance.

The Rehabilitation Engineering Research Center on Hearing Enhancement, website *www.hearingresearch.org*, has a great deal of useful information on assistive listening systems. Other resources include the technical assistance center at Gallaudet University, *www.gallaudet.edu*, and the Access Board, *www.access-board.gov*. The Access Board also provides a toll-free technical assistance number at (800) 872-2253 (voice) or (800) 993-2822 (TTY).

This technical assistance is intended solely as informal guidance; it is not a determination of the legal rights or responsibilities of entities subject to the ADA.

August 2003

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